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(12) **United States Patent**  
**Gordon et al.**(10) **Patent No.: US 6,541,230 B1**  
(45) **Date of Patent: Apr. 1, 2003**(54) **DETOXIFICATION WITH SPONGES OR FOAMS CONTAINING PLURALITY OF ENZYMES AND ENCAPSULATED INDICATOR**(75) Inventors: **Richard K. Gordon**, Potomac, MD (US); **Bhupendra P. Doctor**, Potomac, MD (US)(73) Assignee: **The United States of America as Represented by the Secretary of the Army**, Washington, DC (US)

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(51) **Int. Cl.<sup>7</sup>** ..... **C12N 11/18**; C12N 11/02;  
C12N 11/08; C12N 9/96; C12S 13/00(52) **U.S. Cl.** ..... **435/175**; 435/177; 435/180;  
435/188; 435/262.5(58) **Field of Search** ..... 435/262.5, 177,  
435/174, 178, 180, 182, 175, 188(56) **References Cited****U.S. PATENT DOCUMENTS**

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*Primary Examiner*—David M. Naff(74) *Attorney, Agent, or Firm*—Elizabeth Arwine(57) **ABSTRACT**

A reusable sponge or foam made of a polymer such as polyurethane is prepared containing a plurality of different enzymes or a cross-linked complex of the plurality of enzymes for detoxification of a diverse array of hazardous chemicals such as organophosphorus and/or organosulfur compounds. The plurality of enzymes include enzymes selected from acetylcholinesterase, butyrylcholinesterase, triesterase, pseudocholinesterase, choline oxidase, peroxidase, organophosphate hydrolase, phosphotriesterase, paraoxonase and laccase. A preferred mixture of enzymes contains organophosphate hydrolase and acetylcholinesterase or butyrylcholinesterase. The sponge or foam may additionally contain carbon, an enzyme reactivation compound and/or an indicator for measuring capacity for detoxification. The indicator can be fluorescent, chemiluminescent or visible chromogen or an electrode, and be encapsulated in a liposome or crushable packet. The sponge or foam may be color-coded to indicate specific chemical detoxified, or to indicate enzymatic concentration, activity and/or remaining shelf-life. A kit is formed containing the sponge or foam and the compound for enzyme reactivation.